

QH  
1  
B4X  
NH

v. 12, pp. 113-120

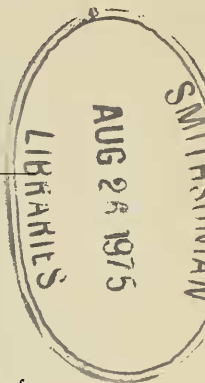
15 August 1975

PROCEEDINGS  
OF THE  
BIOLOGICAL SOCIETY OF WASHINGTON

FRESHWATER TRICLADS (TURBELLARIA)  
OF NORTH AMERICA. VIII.  
*DUGESIA ARIZONENSIS*, NEW SPECIES

BY ROMAN KENK

Department of Invertebrate Zoology, National Museum of  
Natural History, Smithsonian Institution,  
Washington, D.C. 20560



Eight species of the genus *Dugesia* Girard are known at present to inhabit the continental Americas north of the Isthmus of Panama. Two of them are widely distributed over the entire North American continent, *Dugesia tigrina* (Girard) and *D. dorotocephala* (Woodworth). *Dugesia microbursalis* (Hyman), which may be a form of *D. tigrina*, has been reported from the northeastern United States. Four species of the genus have recently been described from Mexico by Mitchell and Kawakatsu, i.e. *D. typhlomexicana*, *D. barbarae*, *D. guatemalensis*, and *D. mckenziei*. A European immigrant, *D. polychroa* (O. Schmidt) has been discovered in the waters of the St. Lawrence River system.

Five additional species of *Dugesia* occur on the Caribbean islands: *D. antillana* Kenk in Puerto Rico, *D. cubana* Codreanu and Balcesco in Cuba, *D. aurita* (Kennel) (a somewhat problematic species) and *D. arimana* Hyman on the island of Trinidad, and *D. festai* (Borelli), a South American species, reported from Curaçao.

The new species described in this paper is an additional member of the planarian fauna of the United States.

*Dugesia arizonensis* n. sp.

Figures 1-3, 5

*Type material*: Holotype from Bog Springs, Arizona, on four slides of sagittal sections, deposited in the collections of the National Museum

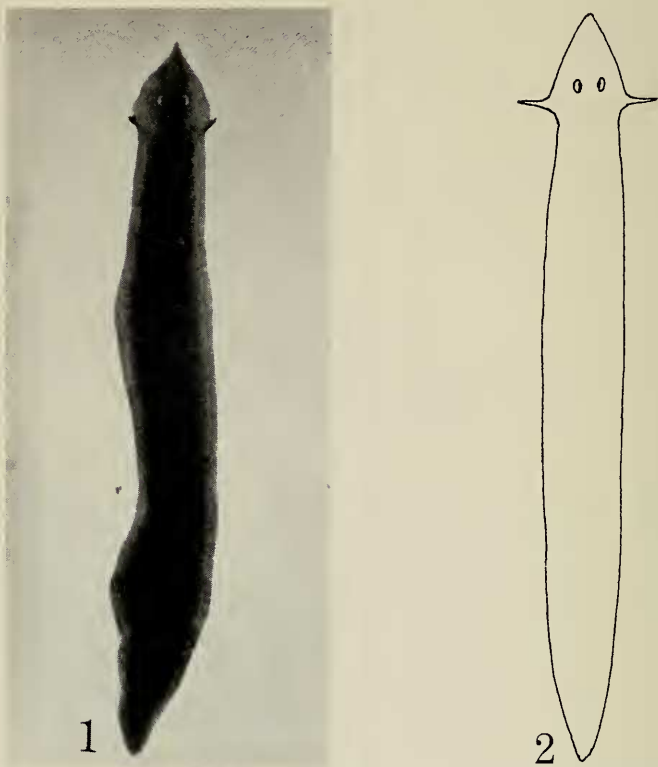


FIG. 1 and 2. *Dugesia arizonensis*. 1. Photograph of living specimen,  $\times 4.6$ . 2. Outline drawing.

of Natural History, Smithsonian Institution, Washington, D.C. (USNM 51980). Paratypes in the author's collection.

*External features:* (Fig. 1 and 2): At first glance, the species resembles *Dugesia dorotocephala* (Woodworth) by its general appearance. Mature specimens from the type-locality, when gliding quietly, are up to 30 mm long and 4 mm wide. Animals from Rucker Creek appear more slender. The anterior end is triangular and sharply pointed, with a rather acute anterior angle. The two sides of the triangle may appear straight (Fig. 2) or slightly curved (Fig. 1). At the base of the triangle is a pair of long, slender, pointed auricles which in gliding are held elevated. Behind the auricles the body is slightly constricted, then the lateral margins diverge gradually and run almost parallel to the level of the copulatory apparatus, where they converge again to meet at the bluntly pointed posterior end. The two eyes are situated anterior to the level

of the auricles. Their distance from each other amounts to about one-third, or a little more, of the width of the head at eye level.

The color of the animals from Bog Springs is brown, almost black, dorsally and somewhat lighter ventrally. Under magnification, the pigment appears almost uniformly distributed, without lighter specks (such as are usually seen in the related *D. dorotocephala*). The mouth and the genital aperture are marked with small white spots. Specimens from Rucker Creek are lighter in color, grayish, with an almost white ventral surface which, however, shows scattered pigment spots under magnification.

*Digestive system:* The intestinal branching is difficult to analyze in the living specimens, particularly in the darkly pigmented individuals, because of the profuse ramification of the intestinal diverticula. The gut area reaches far into the head to a level anterior to the eyes. The pharynx is rather long, measuring about one-fifth the body length, and is inserted behind the middle of the body. Its surface is uniformly pigmented, light gray, leaving only a short area of the tip free of pigment or white. The anatomy of the pharynx corresponds to that of related species of the same genus. Its external surface is covered by a rather thin, ciliated, infranucleate epithelium (about 3  $\mu\text{m}$  thick) underlain by a narrow layer of longitudinal muscle fibers (4  $\mu\text{m}$ ), followed by a thicker sheet of circular fibers (19  $\mu\text{m}$ ). There is no internal longitudinal layer developed, such as is seen in some species of *Dugesia* of the Old World. Then follows a wide (130–170  $\mu\text{m}$ ) intermediate or mesenchymal zone traversed by numerous pharyngeal gland ducts, the cell bodies of which lie in the mesenchyme anterior to the pharyngeal root. The internal muscle zone consists of two muscle layers, a thinner layer of longitudinal fibers (8  $\mu\text{m}$ ) and a wider layer of circular muscles (60  $\mu\text{m}$ ). The internal pharyngeal canal is lined with an epithelium (5  $\mu\text{m}$ ) which is infranucleate in the posterior and nucleate in the anterior part of the pharynx.

*Reproductive system:* The testes (Fig. 3) are subdorsal, arranged in a pair of longitudinal rows beginning a certain distance behind the ovaries and extending posteriorly to the level of the copulatory apparatus. The region behind the gonopore generally is devoid of testicular follicles. Moderate numbers of testes are located in the dorsal parts of the mesenchyme and in the spaces between the intestinal branches. In the zone of the testes, the yolk glands or vitellaria are developed chiefly in the ventral regions, some of them also reaching to the dorsal side. The thin vasa efferentia descend from the individual testicular follicles ventrally and connect, on either side, with the vas deferens which runs along the ventral nerve cord medial to the oviduct. In the region of the pharynx, the vasa deferentia expand to form the usual contorted spermiductal vesicles filled with masses of sperm.

De Beauchamp (1939: 66) reported that in a South American species of *Dugesia*, "*Euplanaria aurita*" [probably *Dugesia festai* (Borelli)], the testes are usually ventral, particularly in specimens which are not

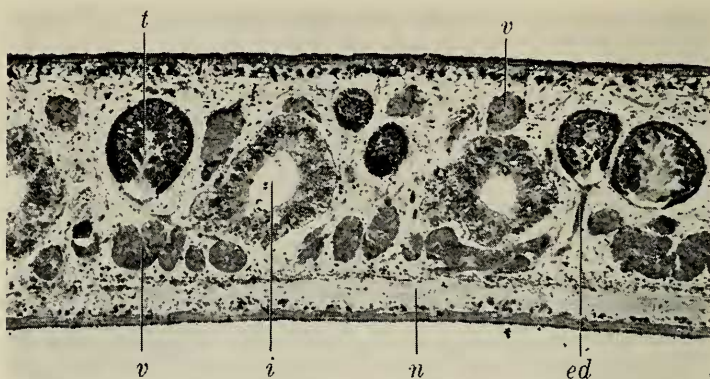


FIG. 3. *Dugesia arizonensis*, parasagittal section of prepharyngeal region,  $\times 74$ . *ed*, efferent duct; *i*, intestine; *n*, ventral nerve cord; *t*, testes; *v*, vitellaria.

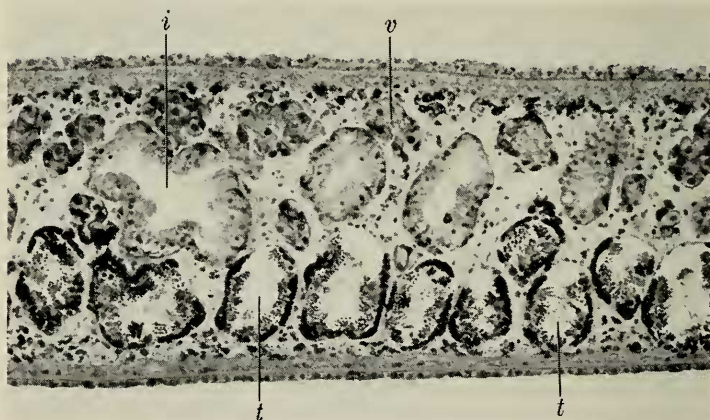


FIG. 4. *Dugesia dorotocephala*, parasagittal section of prepharyngeal region,  $\times 134$ . Abbreviations as in Fig. 3.

fully mature sexually and have the vitellaria incompletely differentiated. Other specimens, however, with fully developed vitellaria, have the testes located exclusively dorsally. He assumes that there is a migration of the testes at full maturity or possibly after copulation. Ernesto Marcus (1960: 46), on the other hand, observed the testes of *D. festai* to be ventral, occasionally extending throughout the dorsoventral diameter of

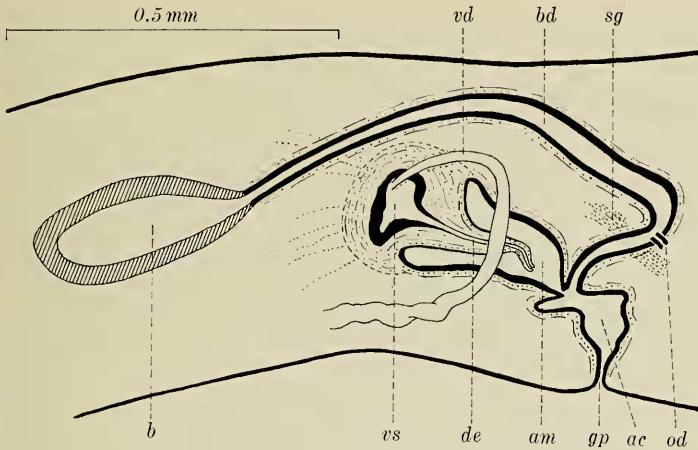


FIG. 5. *Dugesia arizonensis*, semidiagrammatic view of copulatory apparatus in sagittal section. *ac*, common atrium; *am*, male atrium; *b*, copulatory bursa; *bd*, bursal duct; *de*, ejaculatory duct; *gp*, gonopore; *od*, oviduct; *sg*, shell glands; *vd*, vas deferens; *vs*, seminal vesicle.

the body; in only one young individual they were dorsal for a certain distance. Other authors who have examined *D. festai* (Borelli, 1898: 4; Hyman, 1939: 420 [*D. titicacana*]; Eveline Marcus, 1953: 66) indicate that the testes are ventral. Similarly, Ball (1971: 11) reports that he found the testes of *D. arimana* to be predominantly dorsal, except in two specimens, one of which had the testes predominantly ventral on the right side and dorsal elsewhere. The other individual had ventral testes throughout. Ball considers these conditions to be anomalies. Ernesto Marcus (1946: 152) states that in *D. nonatoi* Marcus the testes originate dorsally but, in the fully mature state, are positioned ventrally, with only a few dorsal testes in the postcopulatory region. In *D. hypoglauca* Marcus (1948: 169) the testes are lateral to the vitellaria, originate centrally, but during growth extend to both the dorsal and ventral sides. I have examined sections of 14 mature as well as semi-mature individuals of *D. arizonensis* and find the testes in the semi-dorsal position at all stages.

The paired ovaries, lacking parovaria, are situated at a considerable distance behind the brain, at the level of the fourth to sixth lateral branches of the intestinal trunk. The vitellaria, beginning anteriorly to the ovaries, occupy chiefly the ventral region of the mesenchyme, but also extend dorsally through the spaces between the intestinal diverticula.

The copulatory apparatus (Fig. 5) is somewhat removed posterior to the pharyngeal chamber. The genital aperture (*gp*) leads into the



common atrium (*ac*) which receives the mouth of the bursal canal (*bd*) dorsally and connects with the male atrium (*am*) anteriorly. Between the two atria is a conspicuous constriction formed by folds of the atrial wall which leave only a small round opening connecting the two chambers. The epithelium of the common atrium is cuboidal and, at least in part, infranucleate. That of the male atrium is rather thick, cylindrical, and nucleate. The atrial walls have the usual two muscular layers, a circular one and a longitudinal one.

The penis consists of a moderately developed, round bulb and an elongate, very flexible, easily twisted, pointed papilla, covered by a rather flattened epithelium. The bulb contains a lobed cavity, the seminal vesicle (*vs*), lined with a tall, apparently secretory epithelium. Toward the papilla, with a funnel-shaped transition, the cavity extends into a narrow canal, the ejaculatory duct (*de*), which runs through the center of the papilla, opening at the tip. The lining of the duct is a cuboidal to flattened epithelium. Numerous faintly cyanophilic gland ducts enter the penis bulb from the surrounding mesenchyme. The vasa deferentia (*vd*), which approach the copulatory complex as widened spermiductal vesicles, run posteriorly to the level of the male atrium, then curve upward, bend forward, and enter the penis bulb dorsolaterally. This recurving of the sperm ducts is very characteristic and is seen in all mature specimens. Within the tissues of the bulb, the ducts narrow, acquire a coat of circular muscle fibers, and open into the seminal vesicle separately.

The copulatory bursa (*b*) is a rather large, ovoid sac situated at a considerable distance posterior to the pharyngeal pouch. Its outlet, the bursal duct or bursal stalk (*bd*) runs posteriorly above the penis, widening gradually. At the level of the gonopore, or somewhat more posteriorly, it curves ventrally and proceeds anteroventrally to open into the common atrium. It is surrounded by a dense muscular coat, often rather thick, which is somewhat difficult to analyze. Apparently it consists mainly of circular fibers surrounded by longitudinal muscles. Below the downward bend, the bursal duct receives the two oviducts (*od*) entering separately from the sides. In the adjoining section, many eosinophilic gland ducts, the shell glands (*sg*) open into the bursal stalk.

All epithelia of the copulatory complex are nucleate, with the exception of the lining of the common atrium which is, at least partially, infranucleate.

*Distribution and ecology:* *Dugesia arizonensis* was collected by Dr. Peter D'Eliscu in two localities in Arizona:

Bog Springs in Madera Canyon, Santa Rita Mountains, Santa Cruz County (type-locality). 12 May 1972: 8 specimens, some of them semimature, collected on rocks and organic sediment, water temperature 60° F (16° C), pH 7.2. August 1973: Water flow very slow, temperature 20° C, pH 7.4, several specimens collected. 3 November 1973:

Water temperature 14° C, pH 7.4, about 35 specimens, some of them mature.

Rucker Creek (or West Turkey Creek) in Chiricahua Mountains, Cochise County. 22 September 1973: 7 specimens, all immature (some matured later in the laboratory culture), collected about one-half mile upstream from Rucker Lake, water temperature 18° C, pH 6.7.

Hyman (1931: 324) reported that a species of *Euplanaria* (= *Dugesia*) occurred in mountain springs near Tucson, Arizona, in size and shape similar to *D. dorotocephala*, but with a more pointed head and narrower and longer auricles. As no sexual specimens were obtained, she refrained from describing and naming the species (which had been used by Fraps [1930] in his studies on the respiratory and glycolytic metabolism in planarians). It is highly probable that this species was *Dugesia arizonensis*.

*Behavior in laboratory cultures:* Specimens of the various collections were shipped to me alive and could be maintained in laboratory cultures of dechlorinated (aged) tap water, kept at a temperature of 14° C, and were fed beef liver once a week. Reproduction by fission was observed occasionally. Some of the worms became mature, but no egg capsules were laid in the cultures. The animals have considerable regenerative ability, as is known for all species capable of asexual reproduction by fission. Several individuals were transmitted to Dr. Nicole Gourbault (of the Muséum National d'Histoire Naturelle, Paris) for an analysis of their chromosome morphology.

*Taxonomic relations:* *Dugesia arizonensis* belongs to Ball's (1974: 376) subgenus *Girardia*, which comprises species without penial diaphragm, with the musculature of the bursal stalk consisting of inner circular muscles surrounded by longitudinal fibers, and the testes not confined to the prepharyngeal region. This group has numerous representatives in the Americas and a few in Australia and an Indian Ocean island. The distinctive characters of *D. arizonensis* are the position and number of the testes, the anatomy of the penis, and the configuration of the genital atria. Contrary to the opinion of de Beauchamp (1939: 66), I believe that the location of the testes, whether ventral, dorsal, or intermediate, has some taxonomic significance. A comparison of Figures 3 and 4, showing the arrangement of the testes in *D. arizonensis* and *D. dorotocephala*, illustrates differences which certainly are of systematic value. Cases of secondary displacement of the testes in the course of sexual maturation, such as observed by de Beauchamp (1939: 66) in *D. festai*(?), by Ernesto Marcus (1946: 152) in *D. nonatoi*, and by the latter author (1948: 169) in *D. hypoglauca*, may be exceptional and must be checked by examining individuals in various phases of sexual maturity. Dorsal or semidorsal testes have been reported in 12 of the about 30 species of the subgenus *Girardia*. The pronounced recurving of the vasa deferentia before entering the penis also appears to be a usable characteristic and is known to occur also in

several other species of *Dugesia*, e.g. *D. dorotocephala*. In the anatomy of the penis, the presence of a large seminal vesicle separates *D. arizonensis* from the group of species with a bifid penial lumen. The slender, pointed, and flexible penis papilla is a unique character within the subgenus. Another very characteristic feature is the separation of the male atrium from the common atrium by the striking constriction or atrial diaphragm, a condition which it shares only with *D. arimana* Hyman (see Ball, 1971; 6).

*Acknowledgments:* I am sincerely thankful to Dr. Peter D'Eliscu for his kind collaboration in procuring ample materials of the new species, and to Dr. John C. Harshbarger of the Smithsonian Institution for his aid in preparing the photomicrographs used in this paper.

## LITERATURE CITED

- BALL, I. R. 1971. Systematic and biogeographical relationships of some *Dugesia* species (Tricladida, Paludicola) from Central and South America. Amer. Mus. Novitates No. 2472:1-25.
- . 1974. A contribution to the phylogeny and biogeography of the freshwater triclads (Platyhelminthes: Turbellaria). In *Biology of the Turbellaria* (N. W. Riser and M. P. Morse, ed.): 339-401. McGraw-Hill Book Co., New York.
- BEAUCHAMP, P. DE. 1939. The Percy Sladen Trust Expedition to Lake Titicaca in 1937 under the leadership of Mr. H. Cary Gilson, M.A. V. Rotifères et turbellariés. Trans. Linn. Soc. London, ser. 3, 1:51-79, pl. 4.
- BORELLI, A. 1898. Viaggio del Dr. Enrico Festa nell'Ecuador e regioni vicine. IX. Planarie d'acqua dolce. Boll. Mus. Zool. Anat. Comp. Univ. Torino 13(322):1-6.
- FRAPS, M. 1930. Studies on respiration and glycolysis in *Planaria*. I. Methods and certain basic factors in respiration. *Physiol. Zool.* 3:242-270.
- HYMAN, L. H. 1931. Studies on the morphology, taxonomy, and distribution of North American triclad Turbellaria. IV. Recent European revisions of the triclads, and their application to the American forms, with a key to the latter and new notes on distribution. Trans. Amer. Microsc. Soc. 50:316-335.
- . 1939. New species of flatworms from North, Central, and South America. Proc. U.S. Natl. Mus. 86:419-439.
- MARCUS, ERNESTO. 1946. Sobre Turbellaria brasileiros. Univ. São Paulo, Bol. Fac. Filos. Ciên. Letras, Zool. 11:5-187, pls. 1-31.
- . 1948. Turbellaria do Brasil. Univ. São Paulo, Bol. Fac. Filos. Ciên. Letras, Zool. 13:111-202, pls. 1-20.
- . 1960. Turbellaria from Curaçao. Stud. Fauna Curaçao other Caribb. Isl. 10:41-51.
- MARCUS, EVELINE. 1953. Some South American triclads. Anais Acad. Brasil. Cien. 25:65-78.